5. *CELSAT's Small Cell Design and 1-to-1 Frequency Reuse Pointed the Way*

One of the significant outcomes of the MSS Negotiated Rulemaking proceeding was the modification of MSS applicant designs that occurred during the course of that process. As a result of CELSAT's interference sharing analysis and pioneering design example it became obvious, as it evidently had not been before, that the largest antenna and largest possible frequency reuse factor were the keys to the effective design for MSS interference sharing. As a result of the lessons learned in that proceeding every one of the participants except CELSAT modified its design during the course of that process as follows:[35]

TABLE 1

Major Design Changes Resulting From the MSSAC Proceedings

Time:	# of CONUS Cells		Cluster Size		CONUS Freq. Reuse	
	Before	After	Before	After	Before	After
CELSAT	146	146	1	1	146	146
AMSC	5	6	?	1	?	6
CONSTELLATION	1	7	1	1	1	7
ELLIPSAT	8	37	?	1	?	37
LQSS	6	12	1	1	6	12
MOTOROLA	37	48	12	6	3.1	8
TRW	19	19	3	1	6.1	19

6. *RDSS Band Limitations*

The RDSS band affords one of the few remaining relatively clean bands capable of supporting pure MSS operation. Furthermore, it has been ratified internationally for this service by WARC-92. While this international allocation is essential to globally targeted LEO/MEO systems, it is not necessary for

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[35] See, MSS Majority Report, Section 6.

domestic-only geostationary HPCS systems. This simplifies the deployment process and opens up other possibilities for HPCS.

At the same time, as the severe Radio Astronomy and GLONASS limitations on the 1610-1616 MHz portion of the RDSS L Band have become better understood, it has become clearer that it is essentially impractical to operate the full space/ground hybrid concept in the RDSS L/S-Bands, particularly in a shared environment with non-HPCS MSS systems. Realistically, additional, spectrum (about 7.5-10 MHz) would have to be allocated in some non-contiguous band for the terrestrial HPCS component.[36] These considerations have been instrumental in motivating CELSAT's search for an alternative spectrum assignment.

E. *DESIGNATION OF THE EMERGING TECHNOLOGIES "SPACE BAND" FOR HPCS WILL FACILITATE PROGRESS FOR BOTH PURE MSS AND PCS WIRELESS TECHNOLOGIES*

For reasons totally beyond CELSAT's control the concept of HPCS may be stranded in a "no mans land" if the Commission doesn't take action such as requested by this amendment. On the other hand, MSS and PCS wireless developments are currently also stranded (although on different issues and with somewhat less uncertainty than HPCS). For the reasons below, CELSAT believes that an allocation of the Emerging Technologies spectrum at 1970-1990 MHz and 2160-2180 MHz (the "ET Space Bands") for HPCS could catapult both MSS and PCS technologies off dead center.

1. [redacted] MSS/RDSS Big LEO Proceeding Is Stalemated

allocation choice -- namely, whether there should be multiple MSS entries and, if so, which rules will apply; or whether just one MSS system should be licensed. When and if the Commission can resolve this issue its final choice appears likely to provoke a long and litigious fight.

CELSAT missed the June 3, 1991 technical cutoff date for initial applications in the RDSS L/S Bands and therefore has been unable to participate as effectively in the RDSS proceeding as a full applicant. Consequently, CELSAT has the least possible standing to influence either the pace or direction of that proceeding, and is thereby forced to stand by and await the outcome of a process dominated by others. Although CELSAT remains interested in access to the proposed MSS/RDSS spectrum (relative to its MSS space component only), an alternative course is for the Commission to acknowledge HPCS as a separate service form, and establish a distinct allocation for HPCS systems as proposed herein. In doing so at least some new MSS services (as components of an HPCS system) stand to get off the ground in a relatively near time frame.

2. *Wireless PCS Conflicts Similarly Pose Tough Regulatory Choices*

The Commission faces no less difficult technical and policy issues in its PCS proceeding, Gen. Docket No. 90-314. There, among other problems, the Commission is again confronted with the conflict of accommodating maximum multiple entry (which suggests more licensed systems, but each with less bandwidth), versus ensuring that those PCS systems which are licensed have enough bandwidth (e.g., at least 40 MHz) to operate within while co-existing with incumbent users in the same spectrum.

Questions have also been raised as to:

(i) whether many small, stand-alone PCS operators licensed in discrete geographic market areas will be able to satisfy their customer requirements to roam beyond the geographic reach of their licensed territories;

(ii) whether they will be technically compatible with other systems when they do;

(iii) whether a few nationwide licenses is the only economically and technically sound way to go; and

(iv) indeed, whether many multiple systems having only small regional market areas will attain the economies of scale and other staying power necessary to remain economically viable.

There are also many non-technical, non-economic but nevertheless equally difficult issues related to the PCS licensing structure and eligibility which the Commission and Congress are wrestling with in order to satisfy the many conflicting interests represented in that proceeding.

CELSAT submits that an HPCS approach, particularly its ability to leverage the available spectrum selectively and interchangeably between space and ground uses, will contribute significantly to resolving many of the difficult questions which might be impeding PCS deployment

3. ***Creation of a Separate HPCS Allocation Would Advance PCS in Many Important Ways***

CELSAT submits that an HPCS allocation in the ET Space Bands, and the spectrum leverage which it offers, will neither inhibit nor displace PCS, but will advance it beyond anyone's vision to date. Specifically with respect to the most critical non-spectrum related issues mentioned above, HPCS will:

- maximize the opportunity for multiple entry into the PCS market;
- support the economic viability of those that do enter the market;
- further enhance the spectral efficiency of the overall PCS allocation;
- ensure that no PCS allocation lies fallow;
- accomplish all of the above in the relatively near time frame; and
- not interfere with the Commission's allocations being considered in Gen. Docket No. 90-314 (except as to that portion from 1970 to 1975 MHz).

a. HPCS Will Improve Spectral Efficiency

As discussed below and in Appendix B to this amendment, CELSAT describes a measure of spectral efficiency expressed in equivalent U.S. voice grade (VG) circuits per unit of bandwidth. By this measure an HPCS system can demonstrate unquestionably superior spectral efficiency over any other type of

mobile service capability. As yet another measure of CELSAT's relative spectral efficiency, Table B1 (Appendix C) from the MSS Majority Report illustrates CELSAT's vast spectral efficiency over any other pure MSS system currently being proposed even when such other systems are optimized following CELSAT's lead to maximize their own individual capacities.[37] Clearly, in the context of spaced-based MSS, CELSAT stands alone as the most spectrally efficient system.

In a hybrid PCS context, however, CELSAT's efficiency is yet another order of magnitude greater. As explained above, the ability of an HPCS system to leverage its spectrum by reassigning subbands for ground cellular and microcellular use permits almost endless re-use of the same spectrum allocation, constrained only by the number and size of viable service markets. There could not be a more efficient way for the Commission to both allocate the limited spectrum resource and adequately satisfy the public's need and appetite for PCS and other non-voice wireless services.

In this connection the pressure to increase the proposed PCS bandwidth per system from 30 MHz to 40 MHz to help PCS operators co-exist with incumbents in the major markets should not be met by moving PCS up into the 1970-1990 MHz portion of the ET spectrum. This would consume the only ET spectrum currently available for both space and ground use. Instead, as discussed throughout this section, the Commission can increase its allocation per PCS system to 40 MHz, cut down by one the number of systems per market, make the requested allocation of the 1970-1990 MHz band to HPCS *and still exceed all expectations for ultimate PCS opportunity within the same amount of expanded spectrum that is otherwise being requested for pure stand-alone PCS systems.*

b. Under HPCS No Spectrum Lies Fallow

In contrast to all other proposed operating structures for PCS, the space-based HPCS approach ensures instant, ubiquitous coverage. There will be no service voids, for example, in rural areas or between geographic urban markets where, for lack of demand, microcell PCS systems cannot be cost effectively

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[37] See, Table 1, p. 21, *supra*.

deployed. These remote areas will, at all times, be serviceable by the HPCS satellite using the very same spectrum allocation which, in urban and suburban markets, will also be committed to HPCS ground-based mobile coverage.

In the unlikely event that stand-alone PCS or other microcellular systems prove to be uneconomic or for some reason are not accepted by the public or in some market areas, the PCS portion of an allocation to HPCS will not sit idle over any geographic area until the FCC re-licenses or re-allocates the spectrum for another use. HPCS's multitiered operation -- i.e., interchangeable space, ground cellular, and microcellular services -- ensures the highest probability of success, whereas a commitment to conventional PCS (or MSS) alone offers no insurance against failure or, more likely, against under-utilization of the spectrum.

4. ***HPCS Warrants a Separate, Express Allocation***

While the immediate ET Space Band, for one, does accommodate both space and ground mobile use, there is no traditional allocation which contemplates that both the space and ground mobile systems would be operated on an integrated basis using common spectrum under one license. For example, the 1970-1990 MHz and 2160-2180 MHz pair are allocated for both satellite and ground

LEO/MEO MSS systems are currently deadlocked. And even if a final outcome could be reached relatively soon, none of the systems propose personal MSS services in either sufficient volume or at low enough end user rates to make a noticeable impact on either the availability, the overall economics and/or the viability of PCS services.

While the regulatory obstacles to conventional PCS may be resolved sooner than for MSS, by its nature PCS is intensely infrastructure dependent and will require a relatively long build-out period. Also, the many different technologies being proposed for PCS will challenge the ability of that industry to achieve either standardization or the threshold production levels needed to realize manufacturing economies.

HPCS, on the other hand, is low cost, large scale, large in capacity and volume, yet easily and quickly deployable. Unfortunately, it lacks an express spectrum allocation within which CELSAT or any other proposer could immediately apply for a license. Such an allocation is needed both to ensure an efficient and certain licensing scheme for HPCS, as well as to ensure that less

(Frequency Division Multiple Access).[38] Both are means whereby multiple users can share a single wide bandwidth for different signals without significant interference with one another, but there is a considerable difference in their respective efficiencies with which this is accomplished. In FDMA each user transmits a narrowband signal with a bandwidth of the same order as its baseband information in an exclusively assigned frequency subband or band segment. Multiple users are segregated from one another by frequency filters, and no user has access to any part of another user's band segment, not even at times or in places where it is not being used -- an obvious constraint on efficiency.

In CDMA (or, more generally, spread spectrum)[39] each user generates a *unique* wideband reference signal many times wider than its information bandwidth, modulates information onto it, and transmits the resulting wide band signal across the entire *shared* band with all the other band users. Each particular information signal is segregated securely from all others in the same band by correlation detection techniques using a reference signal identical to, and synchronized with a corresponding unique reference used at the transmitter. Under this sharing technique all sharers have the benefit of equal access to and use of the full band allocation, thereby permitting it to be used more functionally and efficiently.[40]

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[38] See, also, the Commission's PCS Tentative Decision Memorandum Opinion and Order, 7 FCC Rcd. at 5685 and notes 17-19.

[39] It will be noted that this definition does not distinguish between Spread Spectrum, the more general term, and CDMA, a special case of spread spectrum using digitally generated reference waveforms to permit multiple access. Throughout this petition, the term "CDMA" may be read as synonymous with "Spread Spectrum", in accordance with general usage arising from the fact that current non military Spread Spectrum systems are almost universally CDMA.

[40] The efficiency benefits can be analogized to those of a T-1 circuit used in telephony versus 24 individual VG channels. The former (i.e., 24 channels used as a common trunk group) not only permits much greater traffic efficiency, but by allowing access to all 24 channels as a working group it is possible to carry traffic at greater data speeds than would be possible over each circuit operated alone (i.e., greater functionality).

B. *CDMA AFFORDS VERY SIGNIFICANT PERFORMANCE ADVANTAGES FOR HPCN:*

Subject to certain properties, CDMA affords a number of advantages to the HPCS service:[41]

1. *Enables More Energy Efficient Coding*

In an FDMA system there is generally a critical tradeoff between transmission bandwidth and Forward Error Coding Gain. More powerful, lower rate, higher gain coding can save transmitter power, but generally only at the expense of greater transmission bandwidth and, ultimately, in a limited bandwidth at the expense of capacity.

In CDMA, there is no transmission bandwidth nor processing gain penalty[42] for the use of more powerful, very low-rate coding. So it is possible to use higher gain coding, with consequent reduction of transmitter power, intersystem interference, and aggregate gain in band capacity.

2. *Affords Greater Tolerance of Incumbent Transmitter Interference*

Some of the most attractive bands for HPCS service, including the ET Space Bands, are presently inhabited. At least initially, any new system will be required to not interfere with nor claim interference from these incumbent

Historically, the pervasive use of CDMA by the military was primarily to exploit its unique anti-jamming capability -- i.e. an ability to tolerate interfering signals which would jam an FDMA system. Since this is not the principal aim of HPCS design, the amount of interference protection or processing gain afforded in a typical HPCS CDMA service will be much less, typically only 10-20 dB. Nevertheless, in some cases, this can be a valuable component in the ability of a CDMA HPCS system to tolerate interference from other, incumbent services.

3. Provides Greater Protection To Incumbent Services

For closely related reasons a CDMA signal is less likely to interfere with incumbent users, thereby permitting a greater tolerance to share on an *interservice* basis. In military applications this property is exploited for LPI (Low Probability of Intercept) requirements. Again the amount of gain is proportional to the processing gain, typically, 15-20 dB in the anticipated HPCS service.

4. Offers Greater Frequency Reuse Factor

For exactly the reasons in 2 and 3 above, the CDMA signal is also more tolerant of interference from neighboring transmitters in its own system. First, in contrast in an FDMA cellular (ground or MSS) system, it is commonly necessary to isolate frequency re-users from one another by one or more cell diameters. Commonly this results in cellular "cluster" sizes of n=7 to 13, meaning that only $1/n^{th}$ of the total spectrum allocation can be used in each cell.

A CDMA system can inherently tolerate a much higher level of system self-interference and commonly uses a cluster size of n=1, meaning that the frequency is completely reused in *every* cell, resulting in overall regional spectral efficiency (circuits per MHz) many times that of an equivalent FDMA system.

5. ***Enhances Ability to Share with Other MSS***

For the same reason in 2 above, CDMA systems have an inherently greater ability to share the use of a common band on an *intraservice* basis with like MSS services. Seen from a national resource viewpoint as an aggregate over all licensed systems, this leads to a further increase in the frequency reuse factor, greater spectrum utilization efficiency, and enhanced competition.

6. ***Position Determination is Inherent***

A CDMA receiver is required to synchronize its local spread spectrum reference generator to that of the received signal at whatever delay it arrives at the receiver. Having done so, it inherently has available to it the basis of a highly accurate measure of the transit time. Several such measurements form the basis of position determination with an accuracy proportional to the channel or spread bandwidth. An FDMA or TDMA system can, in principle, make the same type of measurement, but its channel bandwidth is commonly much smaller and its accuracy correspondingly less.

7. ***Enables Efficient, Multipath Reception***

If, as is commonly the case in mobile service, the received signal arrives at the receiver via multiple paths of different delays separated by more than the reciprocal of the spread bandwidth, the receiver will discriminate against and ignore those multipath signals that are not being tracked. This largely obviates the multipath interference fading such signals would otherwise induce in a narrowband system such as FDMA.

Even better, at some still practical but additional complexity, multiple receiver "Rake" technology can be incorporated to add the major distinct multipath components *coherently*, not only obviating the fading they would otherwise cause in an FDMA system but additionally taking full advantage of the added signal power in such components.

8. ***Offers "Soft" Handover***

If Rake time-delay diversity reception is incorporated, it is a short step to source diversity and "soft" handover as pioneered and demonstrated by

Qualcomm in its CDMA Cellular development. This affords particular advantages to a multi-level hierarchical cellular structure such as HPCS.

9. Is Compatible With the Emerging CDMA Ground Cellular Standard

CDMA is a fundamental and essential element of what CELSAT and many others regard as the emerging CDMA ground cellular standard proposed by Qualcomm. Field test results of the prototype system to these standards offer convincing proof of the superiority of this standard in terms of capacity and grade of service.[43] CELSAT considers it likely that for Emerging Technologies where the inertia of heavy commitments to older technologies do not prohibit, this CDMA system will become the ground CDMA standard of choice.

C. CDMA SHOULD BE A MANDATORY ELEMENT OF HPCS

Thus, stipulating CDMA for the HPCS rules provides the essential basis and encouragement for the fullest functional integration of MSS with ground cellular-like components, organizationally or otherwise. Only in a fully CDMA environment can the many benefits of HPCS and effective spectrum sharing be realized. For these many reasons CDMA, with certain minimum limitations, should be a mandatory element of the HPCS rules and licensing.

V. HPCS HAS UNIQUE CAPABILITIES FOR SHARING WITH INCUMBENTS

The Commission should make an allocation available for HPCS because it has a superior capacity to share with incumbents, requiring the least amount of near term disruption from relocation of incumbents.

In general, LEO mobile satellite systems cannot share spectrum well with incumbent terrestrial microwave systems. (See, MSSAC Report, at Sec. 3.4.) Similarly, virtually every PCS proponent and applicant in the PCS Gen. Docket No. 90-314 has acknowledged difficulty sharing spectrum in the 2 GHz band with

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[43] CELSAT is proposing to adapt to the emerging EIA/TIA Wideband Spread Spectrum Digital Cellular Standard.

incumbents, notwithstanding their many technical approaches to interference avoidance and various methods and abilities to detect and/or identify inactive frequencies within a proposed allocation and operate within such spectrum "slivers." Indeed, it is for this very reason that the Commission is both proposing a relocation scheme in ET Docket No. 92-9 for relocating incumbents, and pondering whether it will be necessary to allocate more (e.g., 40 MHz) than the initially proposed 30 MHz per PCS licensee in Gen Docket No. 90-314 (i.e., a larger allocation will afford PCS greater opportunity to locate inactive frequencies within the incumbents' operating areas).

A. *BAND CHARACTERISTICS OF INCUMBENT USERS*

CELSAT is proposing a set of rules which both provide for the allocation of the 1970-1990 MHz (e/s) and 2160-2180 MHz (s/e) pair exclusively for hybrid personal communications services, and which tentatively establish a framework for licensing such services.[44]

The designated bands are well suited to HPCS allocation with regard to existing band designations and modes of possible coexistence with the incumbents. Of particular interest is CELSAT's finding, in Appendix F, that while these bands may be approaching saturation from the point of view of fully protected fixed microwave allocations, the clear bandwidth available in areas *outside* the necessary incumbent ground exclusion zones is substantial.

1. *Proposed Allocations*

In ITU World Region 2 (which includes the U.S.) WARC-92 designated each of the bands at 1970-1990 MHz, and 2160-2180 MHz for co-primary MOBILE, *and* MOBILE SATELLITE (after January 1996),[45] as well as FIXED (for present incumbents). These are among the few bands which provide the designations for

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[44] To the extent the Commission concludes that the hybrid concept should be expanded to include more than the two shared systems proposed herein for the ET Space Band at 1970-1990 Mhz and 2160-2180 MHz, CELSAT recommends that the Commission consider reserving the additional ET satellite spectrum at 2120-2150 MHz also for HPCS.

[45] Final Acts, WARC 92, Footnote 746U.

both space and terrestrial components necessary for an HPCS system. Both bands are totally within the FCC designated ET Space Bands.[46] As such they are proposed in the U.S. for clearing of the majority of incumbents over the next three to ten years.[47] Relocation of incumbents is to be encouraged under voluntary negotiations during this period. After such initial period, negotiations would be mandatory for all but local and state government entities.

Additionally, the lower 5 MHz of the earth-to-space band, 1970-1975 MHz, falls within the proposed PCS allocation for a third band pair.

a. The 1970-1990 MHz Band Occupants

CELSAT's database (abstracted from the EMELF) indicates that the 1970-1990 MHz band is occupied by some 1577 fixed, point-to-point microwave links consisting almost entirely of Private Fixed Microwave (Part 94) services of the following types in order of number: Power, Petroleum, Local Government, Railroad, Business and Police. Three hundred five of these occupants are in the category of State or Local Government including public Safety, which are thereby exempt from the proposed future requirements for involuntary relocation negotiations.[48]

Some 90% of the links use 10 MHz channels concentrated and centered at either 1975 MHz or 1985 MHz and the remainder are mostly 5 MHz channels centered at 1970 and 1980 MHz. In some instances one or both channels are operated at 8 MHz bandwidth, leaving either a 1- or 2-MHz opening in the 20-MHz span.

The CELSAT plan for HPCS interference avoidance calls for the clearing of a minimum of one 1.25-MHz subband in the up band (return link) only, *across each entire space cell*. Measured in terms of occupants that must be relocated, the minimum cost (e.g., choosing to clear the least occupied subband of each cell) of such a clearing operation is approximately 330 total incumbents

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[46] PCS Tentative Decision, 7 FCC Rcd. 5676 at notes 15 and 27.

[47] First Report and Order and Third Notice of Proposed Rulemaking, ET Docket No. 92-2, October 16,1992.

[48] Id.

(including some 130 exempt public entities). CELSAT is confident that voluntary negotiations with these users will be economically feasible.

b. The 2160-2180 MHz Band Occupants

This band is assigned primarily to Common Carrier, FCC Part 21 services. Licenses typically are assigned as overlapping or contiguous use of 3.5 MHz, 1.6 MHz or 0.8 MHz bandwidth channels. In addition, in fifty major markets MDS channel 2 is assigned at 2156-2162 MHz. This may deny the lower one or two 1.25 MHz subbands in such areas.

In the downlink there is no need for clearing a subband across each satellite cell as for the uplink. It is sufficient that there be some clear frequency everywhere across the cell even if it is different on one side of the cell than on the other. Since necessary exclusion zones are much smaller than space cells, this is a much more lenient condition.

B. FUNDAMENTALS OF HPCS INTERFERENCE AVOIDANCE PLAN

CELSAT's plan envisions that ultimately most or all of the present occupants may be relocated from the band. At least initially, however, CELSAT can and will share the subject bands with the present Fixed Microwave occupants on a not-to-interfere and not-to-claim-interference basis.

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VI. AN HPCS ALLOCATION GUARANTEES THE MOST SPECTRALLY EFFICIENT AND FUNCTIONALLY COMPLETE USE OF THE ET SPACE BAND

A. UNPARALLELED SPECTRAL EFFICIENCY

Both internal and external spectral efficiency over both the short and the long terms is important. Internal efficiency i.e., the spectral efficiency of a single system, is a function of system design and technology and has been shown above to be best achieved through HPCS. External efficiency concerns the ability both to provide useful functions and to co-exist in the spectrum with others now and over the full life of the system, such that, the band is fully used -- spatially, functionally, geographically and over time.

1. Several Levels of Sharing Possible

No other proposed spectrum use for mobile purposes can promise the degree of spectral efficiency through sharing attainable through the hybrid system concept. As a result of the recently completed MSS Negotiated Rulemaking process it has been shown that while a high degree of sharing *among competing*

LEO/GEO MSS systems is possible, such satellite-only systems *other than CELSTAR* have a very limited ability to share spectrum on an interservice basis *with incumbents*.

Similarly, PCS proponents have identified several schemes for interservice sharing provided, however, that their bandwidth allocation is broad enough (i.e., 15-20 MHz in each direction). Significantly, however, virtually none of the major PCS contenders have indicated an ability to operate in a co-coverage co-frequency intraservice environment or, in other words, share a common spectrum allocation with both incumbents and additional PCS competitors.[51] To date the search for more efficient uses of the scarce spectrum has focused either on shared use with other new licensees (at the expense of incumbents), or sharing with incumbents but not necessarily with each other. HPCS offers the means to do both inter- and intra-service sharing more effectively.

As shown above, through its many "agilities" the CELSAT HPCS design could operate initially with all but a few hundred of the several thousand incumbent microwave systems. Following the band interference sharing techniques developed by CELSAT and borne out by the MSS Negotiated Rulemaking process, it will also be possible to share the ET downlink band among multiple HPCS systems (at least with the space segment of such systems).[52]

Moreover, any contemporary mobile system to be deployed beyond the first half of this decade must offer more than just conventional voice and messaging capabilities. "More of the same", alone, will not only not meet the

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[51] Only a very few PCS commenters have indicated an ability to share a PCS allocation with other coexistent PCS operators in the same market area. Of interest, such proposals are based on the same CDMA modulation technology as proposed herein.

[52] CELSAT does not mean to suggest that multiple HPCS space segment sharing will be possible initially without substantial clearance of the requested band. Only after substantial relocation has occurred could band sharing among competing space segments be practical.

On the other hand, a Commission authorization to more than one HPCS licensee could make relocation more economically feasible for all of them. In any event, to the extent multiple licensees are authorized under this proposal CELSAT is further proposing as a condition to such multiple licenses that each licensee must contribute a *pro rata share* to the cost of relocation. This is the only fair way to ensure that subsequent licensee(s) do not enjoy a "free ride" at the relocation expense of the earlier licensee(s).

needs of the 21st Century, but will be spectrally wasteful. What will be needed are systems that can serve as wireless "platforms," or wireless backbone networks capable of adapting to changing needs and service requirements and interconnecting with the compatible devices of both other licensees and those designed for the needs of tomorrow. As described at length throughout CELSAT's Initial Petition, the very high capacity, correspondingly low unit cost of service, ubiquitous coverage, inherent position determination, and CDMA technology combine to permit HPCS to offer the broadest possible array of basic, new and evolving mobile services -- virtually any requirement that can be satisfied at digital speeds of up to 144 kbps.

Such functionality and adaptability is not attainable through lesser stand-alone MSS or PCS systems. Only the HPCS kinds of adaptable systems, using generic CDMA technology, will not only achieve but also maintain the level of spectral efficiency required *over time.*

2. Other Factors Contributing to Overall Spectral Efficiency

To summarize, the spectral efficiency and related capacity and functional benefits uniquely attainable only through a hybrid, integrated space/ground technical approach to MSS and PCS, CELSAT would highlight the following:

HPCS will be quick to deploy:

> The HPCS combination of space/ground components attains immediate, nationwide *universal* coverage and *ubiquitous* access, including CONUS, Alaska, Hawaii, Puerto Rico and the Virgin Islands, through the early deployment of just the satellite system. An HPCS end user will be able to make or receive an untethered call or other wireless communication at any location within the U.S. over the satellite system. In other words, universality is achieved immediately irrespective of the status of the terrestrial component or infrastructure.

The HPCS system will not require new or additional spectrum to expand to meet demand for growing capacity:

> Instead, the HPCS will spin off one or a few subbands from space to ground use, effectively splitting space cells into a nearly unlimited number of geographically smaller terrestrial cell systems, each able to fully reuse the one or two subbands in both contiguous and non-contiguous terrestrial cells. Such space cell splitting will be deployed selectively on an as needed basis, beginning in the most populated markets. (Dynamic reassignment of subbands from space to

ground or vice versa in near real time will also be possible to meet, for example, the demands of a major disaster.) While this process, once built-out on the ground, can add potentially another 1,000,000 equivalent VG channels of HPCS capacity, the reassignment of three subbands of the total of 15 available in all 117 space cells, for example, reduces the effective MSS total space capacity by a mere 6%!

B. *UNPARALLELED UTILITY AT LOWEST COST*

One of the most salient attractions of the HPCS approach to spectrum utilization is the unparalleled functionality that it promises at an extremely low economic cost.

1. *"Utility" and "Price" are Influenced by Capacity:*

As noted above, HPCS is capable of tremendous capacity in terms of equivalent VG channels for communications. Also, HPCS cost of deployment is relatively low so that cost and capacity together result in a very low potential unit charge to the end user. Both high capacity, low unit price, and bandwidth-on-demand assure a greater variety of available bandwidths for a greater variety of services and applications, including those requiring data speeds higher than previously attainable by any other wireless service, all on a cost effective basis.

2. *"Utility" is Related to Geographic Coverage*

A satellite-based HPCS offers universal coverage and ubiquitous access; it is therefore immediately more useful to end users who can be assured of being reached or being able to reach someone else wherever they might be. Both its breadth of coverage (nationwide) and its potential for concentration (microcells) similarly increases the number and types of applications which HPCS can serve, and the purposes to which users or businesses might choose to apply its capabilities.

3. *"Utility" is Related to Control/Intelligence*

CELSAT's HPCS concept relies on a network controller for, among other things, maintaining control/contact with the end user, irrespective of whether the active communication path is a space or ground channel. The satellite control link also feeds constant position determination to both the HPCS network,

and, optionally, the end user terminal, as well as other useful intelligence (e.g., class-of-service, time-of-day, account and billing data). Thus, continuity of control not only adds intrinsic value to the service, but makes still further applications and functions possible.

4. *"Utility" and "Price" are Related to Volume and CDMA Technology*

HPCS' low service price will attract very large numbers of customers; its tremendous capacity will ensure a good grade of service for a variety of applications. Such large volumes and diverse applications will, in turn, support cost effective, high volume production of both standard mobile telephones and more esoteric special devices. Moreover, the potential for large production volumes will permit use of the most contemporary device technologies and manufacturing processes.

An HPCS allocation based on mandatory CDMA modulation will facilitate standardization, similar to the pending cellular industry CDMA standard, and will ensure a very high degree of security and privacy of communications. Finally, use of CDMA will enable hybrid systems to serve as an alternative platform, interconnectable to compatible CDMA devices operating with, but geographically out of range of other wireless systems licensed in non-contiguous, non-HPCS frequency bands.

VII. CELSAT'S PROPOSED AMENDMENT TO ITS RULEMAKING PETITION

CELSAT is proposing a set of rules which both provides for the allocation of the 1970-1990 MHz and 2160-2180 MHz pair exclusively for hybrid personal communications services, and which tentatively establishes a framework for licensing such services.

A. *THE 1970-1990 MHZ AND 2160-2180 MHZ BANDS (ET SPACE BAND) SHOULD BE ALLOCATED FOR HPCS ON A PRIMARY BASIS OVER THE UNITED STATES*

Under the scheme of rules proposed herein CELSAT reasonably believes that there could be multiple HPCS systems operating before the end of this

decade. Such multiple systems would not necessarily resemble each other (e.g., they could include a mix of LEO and GEO systems) other than to the extent that they will all: (i) have integrated space and ground components,[53] and (ii) conform to the minimum technical and operating criteria needed to ensure shared use of the spectrum -- that is, principally, employ one or other compatible form of CDMA spread spectrum sharing under mutual EIRP and PFD limiting constraints.

Accordingly, CELSAT proposes that the Commission allocate the subject ET Space Band for HPCS use with mandatory interference sharing requirements as proposed herein and as attached at Appendix A.

1. Definition of HPCS

In its Initial Petition CELSAT proposed to amend Part 25, at Subpart A, Section 25.103 of the Commission's rules by adding a definition for hybrid personal communications services networks (HPCS).[54] While CELSAT's initial definition is still generally accurate, it is being adjusted to reflect a shared environment and the other potential constraints imposed by the necessity initially to share with incumbents.[55]

2. The ET Space Band Is Both Technically and Politically Suited for High Capacity HPCS

As noted in the PCS docket by CELSAT and others, very little spectrum earmarked in the Emerging Technologies band is suitable for mobile satellite services. Of that being considered, the 1970-1990 MHZ and 2160-2180 MHz band pair is the most promising from the stand point of the ease of relocating

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[53] As discussed, *infra*, the space and ground components would not have to be in the same band; HPCS can be operated, for example, in non-contiguous bands, the other of which might be allocated only for ground mobile. CELSAT submits, however, that the most efficient allocation, providing for demand adaptive space/terrestrial subband reassignment is one that provides for both space and ground use in one contiguous band.

[54] Initial Petition, pp. 39-40.

[55] For example, the quantification for minimal spectral efficiency of 1000 5 kbps space channels/MHz may be too high; use of all subbands would not be feasible in all space cells; and a non-contiguous allocation might not permit dynamic reassignment of ground and space cells, etc. The definition should be renamed, however, for "Hybrid Personal Communications services".